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(54) A mold and a method for manufacturing semiconductor devices of plastics incorporating an exposed heat sink of metal for inspecting the soldered joint.

(57) A mold (10) is disclosed for semiconductor devices intended for surface mounting, being of a type which comprises a metal plate (12) and a plastics body (20). It consists of two plates (10a,10b) which delimit at least one hollow (11) adapted to receive the plate (12) and to contain plastics for forming the device body (20). Two elements (16) of the mold (10) push the plate (12) from opposed sides against the bottom of the hollow (11). The hollow (11) has two side extensions (18) which are delimited by the side surfaces of the plate edges, thereby plastics projections (22) are formed thereon which separate readily after the molding process. Thus, a structure is obtained wherein the plate (12) has its bottom surface and two side edge portions fully exposed to allow of optimum and controllable soldering to a printed circuit board.

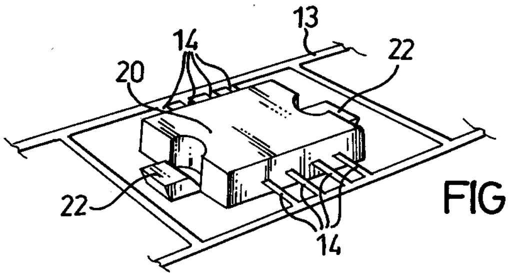

FIG.3

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This invention relates to the manufacture of semiconductor electronic devices, and more particularly, to a mold and a method for manufacturing a semiconductor device structure intended for surface mounting and being of a type which comprises a metal plate and a plastics body joined to each other.

As is known, integrated circuits and other active electronic devices or components are built up on plates (chips) of a semiconductor material having a surface area on the order of a few square millimeters, and require for their connection to an external electric circuit special supporting, enclosing and electric interconnection structures. A typical structure suited for the purpose comprises basically a plastics body enclosing a chip which is connected, by thin wires soldered to metallized regions specially provided on its surface, to corresponding electric conductors or terminal rheophores led out of the plastics body. With power integrated circuits, that is devices designed to operate on high currents, and therefore, liable to become heated to a significant extent, such structures also comprise a small metal plate through which a chip mounted thereon can transfer the heat generated during its operation to the environment.

In manufacturing the last-mentioned structures, the plate is blanked off sheet metal, e.g. copper; thereafter, a chip is secured on the metal plate either by soldering with a low-melt alloy such as a lead-tin alloy, or by cementing with a suitable adhesive such as an epoxy adhesive; a set of metal strips, intended to become the terminal rheophores for the device, are then blanked off thin sheet metal but still left joined to one another by interconnecting sections, and mounted to the plate in an electrically insulated manner therefrom; thin wires, usually of gold, are soldered, on the one side, to the metallized regions of the chip using a low-melt alloy, and on the other side, welded to the ends of the metal strips using a so-called "thermosonic" process wherein heat and ultrasound are applied simultaneosly; thereafter, the assembly is placed into a specially provided mold, into which a plastics material such as a thermosetting epoxy resin is then introduced in a liquefied state; on curing the resin, a structure is obtained which comprises a solid plastics body encapsulating the above-described elements excepting for one face of the metal plate and part of-the metal strips, i.e. of the device terminal rheophores, and their interconnecting sections; the latter are then removed, along with any interconnecting sections present, as by blanking to yield the finished electronic product.

With devices intended for surface mounting, that is for attachment to a printed circuit board by welding the heat sink and the rheophore ends to specially arranged metal regions, all located on the same board surface, the rheophores are bent to have their free ends all lying in the plane which contains the exposed side of the heat sink. The soldering is performed by applying a low-melt solder layer onto the metal regions of the board and then arranging the circuit components on the board with their respective terminals, and in the instance of devices of the kind described above, with the exposed side of the heat sink, in contact with the metal regions, and by heating the board to melt the solder layers and thereby have the terminals and heat sinks soldered on cooling to their respective metal regions.

The soldered joint quality is then inspected for appearance and shape. With semiconductor devices which incorporate a heat sink, this inspection cannot or can only imperfectly be carried out because the border line between the heat sink and the solder are concealed from view. Further, checking that the heat sink is correctly aligned to the corresponding printed circuit area also becomes more difficult due to that border line being hidden from view.

To obviate such drawbacks, structures have been proposed wherein the metal plate of the heat sink has exposed edges on two opposed sides of the structure. To make such structures, however, a special, critical and troublesome, additional machining step is required to rid such opposed edges of the plastics that forms all around the plate during the molding process.

Another machining step which becomes usually necessary to prepare such structures for soldering is the removal of thin plastics layers which form on the outward side of the heat sink due to seepage during the molding process. To prevent such seepage, there are known molds having shaped interiors to present elements for pushing the metal plate against the bottom of the hollow wherein the plastics body of the structure is to be formed.

It is the object of this invention to provide a mold and a method for manufacturing structures as indicated, which neither require post-machining to remove plastics that has seeped onto the heat sink nor any other troublesome machining to remove plastics from the heat sink edges.

This object is achieved by providing the mold and implementing the method as are defined and characterized in the claims at the close of this description.

The invention can be more clearly understood from the following detailed description of an exemplary and non-limitative embodiment thereof, given with reference to the accompanying drawing, in which:

Figure 1 is a cross-sectional view through a portion of the mold according to the invention;

Figure 2 is a plan view of the lower plate of the mold shown in Figure 1;

Figure 3 is a perspective view of a semiconductor device structure as it appears directly after molding; and

Figure 4 is a perspective view of a finished semiconductor device structure as obtained using the mold and method of this invention.

With particular reference to Figures 1 and 2, a mold, generally denoted by 10, comprises two superimposable plates or halves 10a and 10b. The two half-molds, when superimposed on each other, will delimit on their interiors hollows which are connected to an inlet by suitable channels, not shown. Through these channels, a plastics, such as a thermosetting epoxy resin, in a liquefied state can be injected into the hollows under a pressure to fill them.

Shown in Figure 1 is a mold portion having a hollow 11 formed of two compartments correspondingly provided in the two mold halves. A blank piece comprising a metal plate 12, a chip of a semiconductor material attached to the plate, and a framework 13 of rheophores 14 electrically connected to the chip is placed into the lower compartment. In the interest of simplicity, the drawing Figures 1 and 2 only show the metal plate 12 and the framework 13. It can be seen that the plate 12 is formed of a broad portion, rectangular in shape, and two wings 12a which extend from the small sides of the rectangle and are slightly sunk with respect to the top surface of the plate.

The upper mold half 10a has two pusher elements 16 which, with the mold closed and the blank piece placed within the hollow, engage surface areas 17 of the plate with their free ends so as to hold it pressed against the hollow bottom.

The lower compartment of the hollow 11 extends sideways into two recesses 18 which, with the plate 12 inserted into its socket in the lower mold half 10b, are covered by the thickness of the wings 12a, specifically by the side surfaces of their end edges, extend inside the lower mold half, and are covered at the top by a flat portion of the upper mold half 10a. They are also communicated to the resin inlet by channels, not shown.

As the resin is injected into the mold in a liquefied state, it fills the hollow completely, including its side extensions 18. After curing, a structure like that shown in Figure 3 is taken out of the mold. It consists of a solidified plastics body 20 whence the metal strips 14 protrude of the device terminal rheophores, held together by the framework 13, and which encapsulates the plate 12 to only leave its bottom surface, not shown in the drawing, free which was held in contact with the bottom of the hollow during the molding process. The structure also has two projections 22 formed by resin flown into the recesses 18 and only being joined to the remainder of the structure along the edges of the wings 12a of the metal plate 12. According to the invention, these are then separated from the remainder of the structure using a suitable tool. Thereafter, the framework 13 sections that hold together the rheophores are shorn off. Finally, the rheophores are bent over as shown in Figure 4 such that their end portions will lie in the bottom plane of the structure. Presently the device is ready to be soldered to a surface of a printed circuit board.

Thus, the mold and method of this invention provide a device which is ready for surface mounting with no post-machining apart from the simple separation of the projections 22, since the surface of the heat sink is free of any traces of resin from seepage due to the elements 16 being pressed against the plate 12, and the edges of the latter are, limited to the span of the wings, completely free of resin because of the parting surfaces of the projections 22 from the structure being defined by said edges, indeed. Notice that the thickness of the wings 12a is reduced, conveniently, from that of the remainder of the plate 12 to both facilitate separation of the projections 22 and improve the mechanical anchoring of the plastics body 20 on the plate 12.

While a single embodiment of the invention has been described and illustrated, it is understood that many variations and modifications are possible within the same overall inventive concept. As an example, the pusher elements 16 could be constructed such that the surfaces 17 of the plate contacting them have shapes and dimensions other than those shown, and as a result, the wings 12a also have shapes and breadths other than those shown, it being possible, in the extreme, to extend them to span the full width of the plate 12.

Claims

1. A mold for manufacturing a semiconductor electronic device structure, being of a type which comprises a metal plate (12) and a plastics body (20) encapsulating the plate, while leaving at least a major surface thereof substantially unoccupied, and comprising two superimposable plates (10a, 10b) jointly delimiting at least one hollow (11) adapted to receive the metal plate (12) with said major surface held in contact with a bottom wall of the hollow and to contain a predetermined amount of plastics to form said body (20), and comprising, for each hollow (11), means (16) effective to push the plate (12) against said bottom wall while engaging at least one surface area (17) thereof delimited by one plate side, char-

acterized in that it is designed such that each hollow (11) has at least one side extension (18) which, with the mold closed and the plate inserted into the hollow (11), is delimited by the lateral surface of said plate (12) side and the inner walls of the mold.

2. A mold according to Claim 1, characterized in that the plate (12) pusher means are two elements (16) acting on two surface areas (17) of the plate being each delimited by one of two opposed sides of the plate, and that it has two side extensions (18), each delimited by the lateral surface of one of said opposed sides.

3. A method for manufacturing a semiconductor electronic device structure comprising a metal plate (12) and a plastics body (20) which encapsulates the plate while leaving at least a major surface thereof exposed, by using a mold according to either Claim 1 or 2, the method comprising the steps of:

introducing a blank piece including said metal plate (12) into at least one hollow (11) of the mold (10);

injecting plastics in a liquefied state into the hollow (11);

curing the plastics; and

taking out of the mold (10) a blank piece consisting of the metal plate (12) and the plastics body (20) resulting from the preceding steps;

and characterized in that it further comprises the step of removing the portion(s) (22) of plastics formed in the side extension(s) (18) of the hollow while separating them from their respective side surfaces of the plate.

4. A method according to Claim 3, characterized in that the blank piece is obtained from a substantially quadrilateral-shaped metal plate (12) having two wings (12a) which extend from two opposed sides, the end sides of such wings defining said side surfaces of the plate.

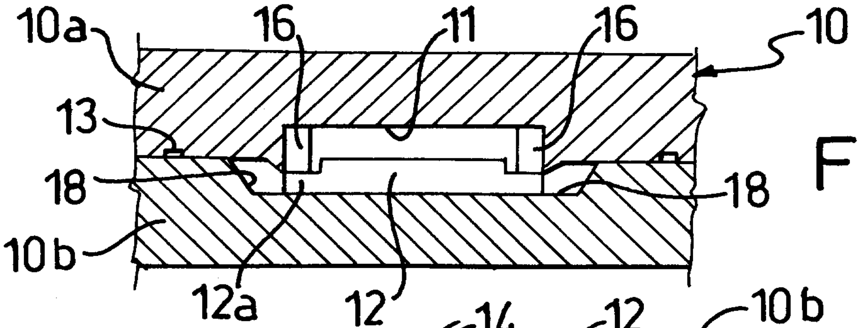

FIG.1

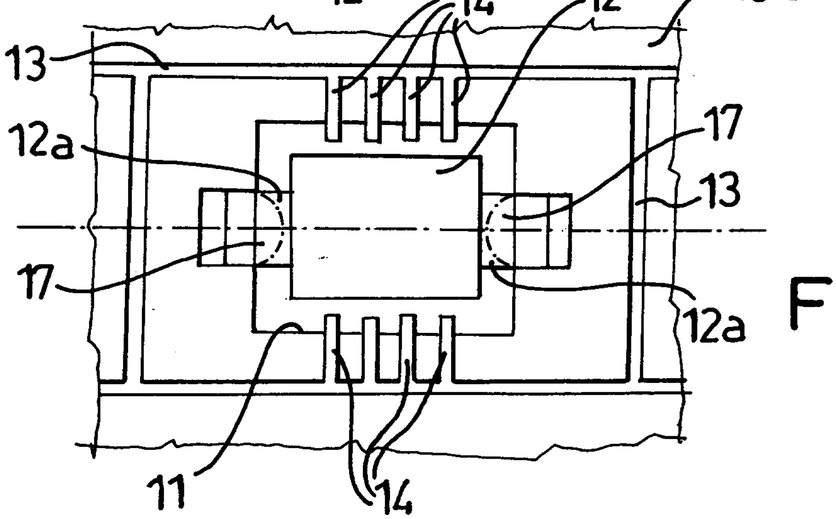

FIG.2

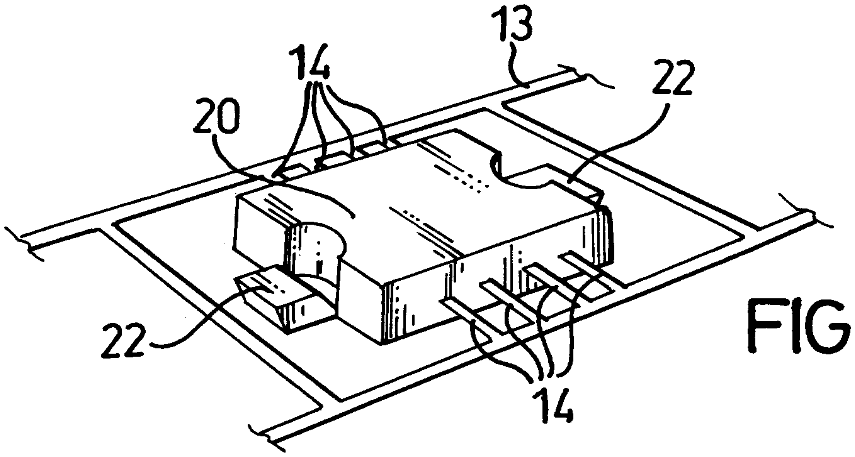

FIG.3

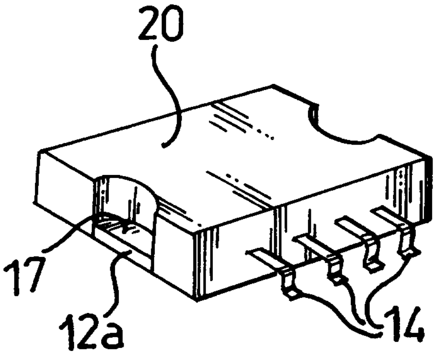

FIG.4

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EUROPEAN SEARCH REPORT

Application Number
EP 92 11 8078

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	PATENT ABSTRACTS OF JAPAN vol. 015, no. 098 (E-1042)8 March 1991 & JP-A-23 06 639 (TOSHIBA) 20 December 1990	1	H01L21/00 H01L21/56
A	* abstract * ---	2-4	
A	DE-A-2 900 114 (DAI-ICHI SEIKO LTD) * page 13, line 19 - page 17, line 7; figures 3,4 * ---	1,3,4	
A	US-A-4 822 550 (KOMATHU) * column 3, line 31 - column 3, line 43; figures 7-8B * -----	1,3,4	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			H01L H05K
	The present search report has been drawn up for all claims		

Place of search	Date of completion of the search	Examiner
THE HAGUE	15 MARCH 1993	BOLDER G.

CATEGORY OF CITED DOCUMENTS

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